

EPOC – Embedded Performance Analysis for Embedded Systems

Results and Future Objectives

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Outline

- Project Reminder
- Report on Phase II
 - Recap: ToDos
 - Platform
 - Analysis Engine
 - Performance Control Framework
 - Conclusion
- Objectives Phase III



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Embedded Performance Control





ToDos in Phase II

- Optimization Framework
 - First Step: Self-Protection during Update
- Adaptation Mechanisms
 - Priorities on CPUs / Busses
 - Taskmigration
- Embedded Analysis Engine
 - Distributed
 - Ported to target Architecture
- An Embedded Platform





Platform









Analysis - Challenges

- Distributed Analysis (solved in P I)
 - Extend Model
 - Adapt global steering algorithm
- Schedulability analysis in bounded time (solved in P II)
 - Fix-Point algorithm

RK ENGINEERING

- Theoretically unbounded run-time
- System analysis in bounded time (unsolved P III)
 - Fix-Point algorithm over multiple WCRT analyses
 - Convergence criteria unclear
 - If multiple exist, which fix-point will be found?
 - Choice of initial values important for iteration?





WCRT Analysis

- Define bound for number of iterations
- Deem problems not analysable in this time infeasible
- Do we discard relevant problems?
- Study of SPP Algorithm submitted to DATE'09
 - Most problems can be computed in limited time
 - Complex problems result in large WCRT



Analysis Engine Implementation

- Basic Algorithms taken from tool
 - Distributed algorithm controlling global analysis
 - Using simple model (extensions possible)
 - Implemented for both Platforms
- Implementation in plain C
 - Compiles for PPC and ARM

ORK ENGINEERING

- On top of uC/OS-II
- Communication via Message Passing
- Small, Fast
- WCRT Analysis in 14ms for large systems
- Memory Footpring of 35kB (Code + Data)





Embedded Performance Control





Performance Control

- Use-Case: Self-Supervised Update
 - Also enables Optimization loop
- Management Framework
 - Model Data
 - Execution Control
 - Approach: Strict Seperation
- Optimization Options
 - Task Migration
 - Communication Medium Adaptation
 - Task Priority Adaptation



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Annotation Domain





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Execution Domain





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Middleware





OcCAN Architecture



Memory Footprint





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Middleware Latency

Receive



Packet Size



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Send

Dissemination

- Steffen Stein, Rolf Ernst "Distributed Performance Control in Organic Embedded Systems" in Design Automation and Test in Europe, Workshop, Munich, 2008
- Steffen Stein, Markus Homeister and Rolf Ernst, "Evolving Real-Time Systems", Design Automation and Test in Europe, University Booth, Munich, 2008
- Simon Schliecker and Steffen Stein and Joern-Christian Braam and Martin Schnieringer. "System Level Performance Analysis with Formal Methods and Virtual Prototyping", Embedded World Conference, Nürnberg, Germany. February 2008.
- Steffen Stein and Rolf Ernst. "Distributed Performance Control in Organic Embedded Systems." In Autonomic and Trusted Computing (LNCS), Volume 5060/2008, pp 331-342, June 2008.
- Patents on detailed protocols pending
- Steffen Stein and Rolf Ernst. "Solving schedulability fix point equations under time constraints" submitted to *Design Automation and Test in Europe (DATE)*, Nice, 2009



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CABOLO-WILHELMI

Cooperations

- Prof. Teich (Erlangen)
 - Task migration
- Prof. Thiele (Zürich)
 - Theoretical foundations of analysis
- Prof. Rosenstiel (Tübingen)
 - ASoC as platform (reliablity estimator)



Conclusion – Past Work

- Set up an embedded hardware platform
- Theoretical work on properties of analysis algorithms
- Developed Control Architecture
 - Strictly seperating Annotation/Execution Domain
 - Enabling
 - Self-Supervised Updates
 - Optimizations (Task Migration, Scheduling Adaptivity)
- Implemented Important parts of the Architecture





Current Activities



- Demonstrator (University Booth DATE'09)
- Patent(s) (Publications afterwards)
- Proposal for Phase III





Planned Activities for Phase III

- Observation facilities
- Optimization Engine(s)
 - Explore strategies
 - Quick Response
 - Long-Term Optimization
- Integration of work done in AiS-Project (BMBF)
 - Fault Analysis
 - PFD on Communication Media
- Demonstrators







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EPOC Framework -Architecture





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Framework

- Architecture strictly seperating Annotation and Execution Domain
- Communication Middleware (API close to AUTOSAR)
- Adaptation Mechanisms
 - Task Migration
 - Communication Medium Management





Outline

- General Architecture •
- Annotation Domain •
 - Timing Model
 - Optimizations
- Execution Domain
 - Task Migration
 - Run-Time reconfiguration
- Communication Middleware
- **Reconfiguration Example: CAN Bus** •
- Performance Metrics •



